VOL. 1 No. 4 August 1984

COMPUTERDIGEST

NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

IBM COMPATIBILITY...

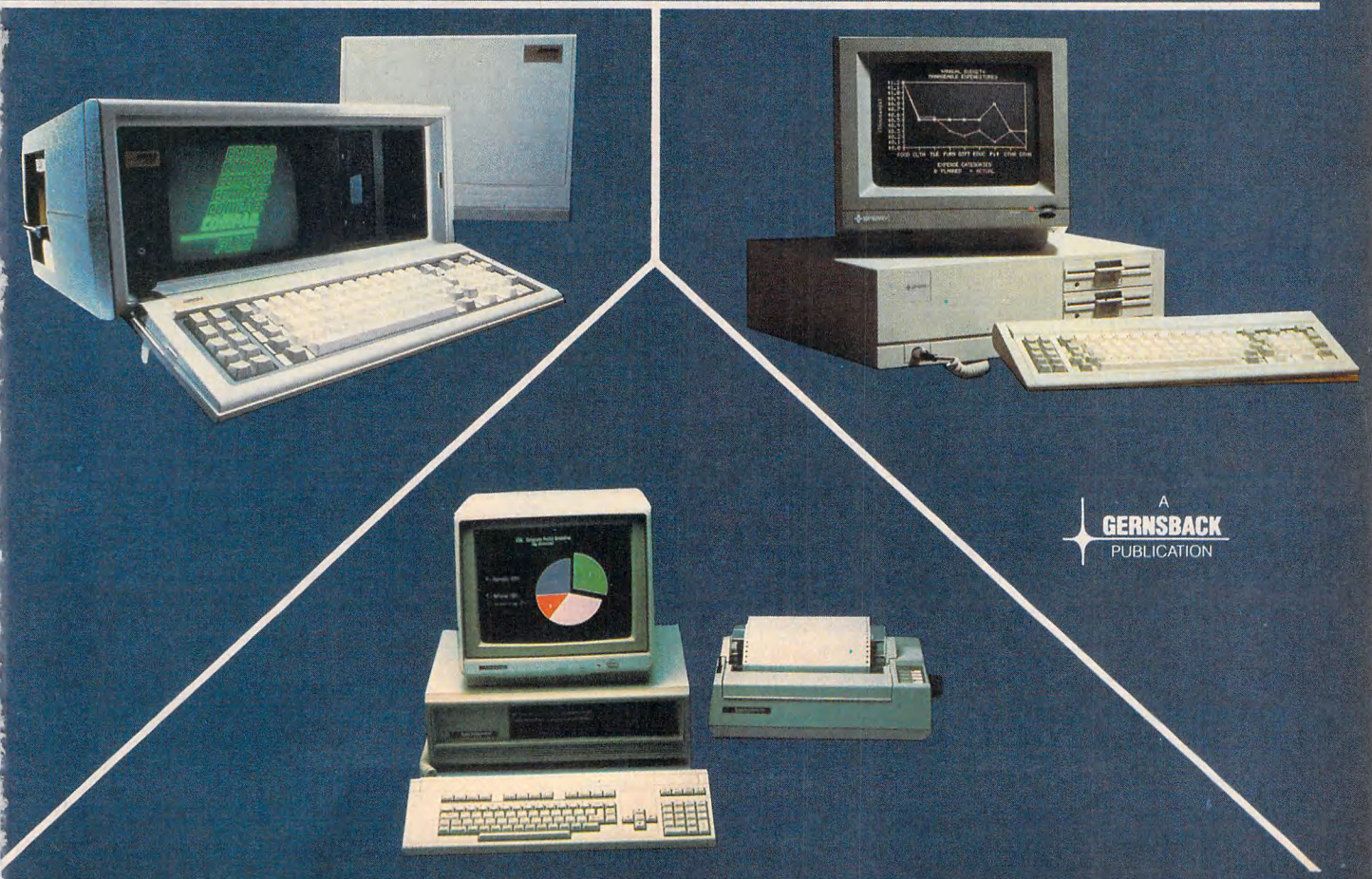
It's a claim many computer manufacturers make. But just HOW compatible IS your computer?

SOFTWARE DIAGNOSTICS

New software will analyze your disk drives and pinpoint problems before they start.

MAKE YOUR COMPUTER'S MEMORY SAFE

When power fails, you could lose the entire memory. Here's how to keep that from happening.



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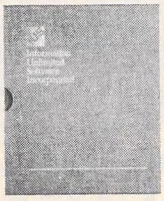

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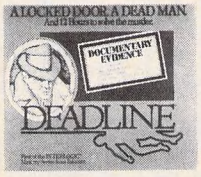

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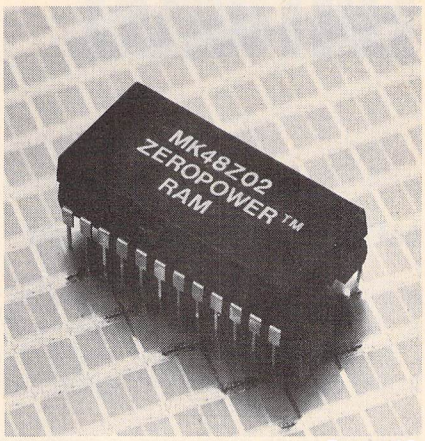

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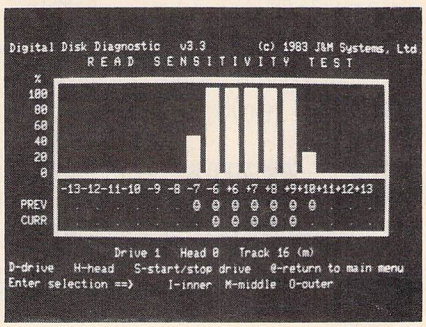

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ON THE COVER

The desktop dream machines, reading clockwise from the upper left, are the Compaq, Sperry, and TI. All claim IBM compatibility, too. See page. 5.

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NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS
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EDITORIAL

Let's set the record straight.

■I was having dinner with a friend last night, and he commented that I've probably got—to use his words—a very "cushy" life. "You sit around in a big, walnut-panelled office all day, giving orders, pretty secretaries running in and out, three-hour lunches...You've really got it made!"

'Taint so. Much of my work is done in my bedroom at home, working at my typewriter, wearing only a pair of shorts. When I can spend time at my "office," where I just happen to be right now, I'm in a room perhaps ten feet wide by about fourteen feet long. The computer terminal at which I'm working sits on a Formica-topped table, perhaps four-by-six feet in size, and the room is filled with a bunch of mysterious cartons, an old copying machine, a green metal cabinet or two, and a bank of file cabinets. Glamorous? Hardly.

I'm certain that someplace this side of Hollywood, there may be an editor or two that lives the kind of life my friend's fantasy called up, but I've never seen it, and frankly, I hope I never do.

Editing a magazine is simply hard work. It's exceedingly rewarding work, but it's also hard work. What makes it rewarding is getting mail from people like you, who read the magazine, who tell us that they appreciate what we're trying to do. That makes it all worthwhile. Ask any editor worth his salt what he does for a living, and before long, you're going to hear him talk about his readers. You, the reader, are what it's all about. For example an editor might be personally interested in a subject covered by a manuscript that comes in from an author, but the acid test of whether or not the manuscript is purchased, is "How much reader appeal will it have?" Each and every decision that an editor makes is based on the reader's point of view.

That's why we want to hear from you. We're starting a "letters" column with this issue of **ComputerDigest**, and we'd like some feedback from you. If you like what we're doing, please tell us. If you don't like it, tell us that, too. Got some suggestions on how we can improve things? You'll be amazed at how we listen!

Of course, editors *do* make certain decisions on their own. For example, I just decided—on my own—I'm going to get a cup of coffee.

BYRON G. WELS
EDITOR

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IBM COMPATIBILITY

IBM compatible? Sure! But just how compatible?

MARC STERN

■In the world of personal computers, there's probably no more controversial a topic than compatibility. There are so many stories about it because so many manufacturers want to make their systems just a bit different from others on the market.

Why? Most likely, it's the result of an effort by computer manufacturers to marry users to one company for all their peripheral and software needs. And who can blame them? It seems to make eminently good business sense (at least to the manufacturers—not necessarily to the consumers). But it has led to an abundance of incompatible operating systems, incompatible disk formats and sizes, and incompatible programming languages.

Frankly, it's a confusing, aggravating situation for the average computer user. It's a situation about which many computer users complain, but also about which they have very little control. The various manufacturers have control of the situation—and, for competitive reasons, it's unlikely they will agree on standards in the near future.

Halting steps forward.

By and large, that situation is likely to exist in the personal-computer world for some years to come as droves of computer manufacturers enter, compete and leave the industry and new competitors take their places.

There have been some halting steps toward standardization. It's not due to any cooperation between the manufacturers. It's because of the dominant presence of certain disk-operating and personal-computer systems in the marketplace. For example, the CP/M operating system has brought a measure of standardization to the 8-bit computer world, while the IBM *Personal Computer* and its operating system, PC-DOS, have brought some standardization to the 16-bit world.

Why have these two forces been so dominant? With CP/M, quite simply, it has been a matter of longevity and ubiquity. It was one of the earliest disk operating systems in the microcomputer world and, as such, many programs were naturally written to run under it.

For the IBM *Personal Computer,* the story is much the same. Because IBM is so dominant in the world of computers and because its *PC* has become a major force in the market, it was inevitable that it would become the standard in the 16-bit world. Even the 16-bit version of the venerable CP/M system couldn't compete with it (apparently because of poor marketing decisions).

Limited standards.

Since CP/M has become the *de facto* standard in the 8-bit world and since it has been covered in the pages of **ComputerDigest** (May and June 1984), we will concentrate on what is becoming the standard in the 16-bit world, MS-DOS, or, as it is also called, PC-DOS, the operating system of the IBM Personal Computer and "compatibles."

At the start, let's understand that even though advertising hype may say a computer is "PC-compatible," the range of that compatibility can vary greatly. There are computer systems on the market—

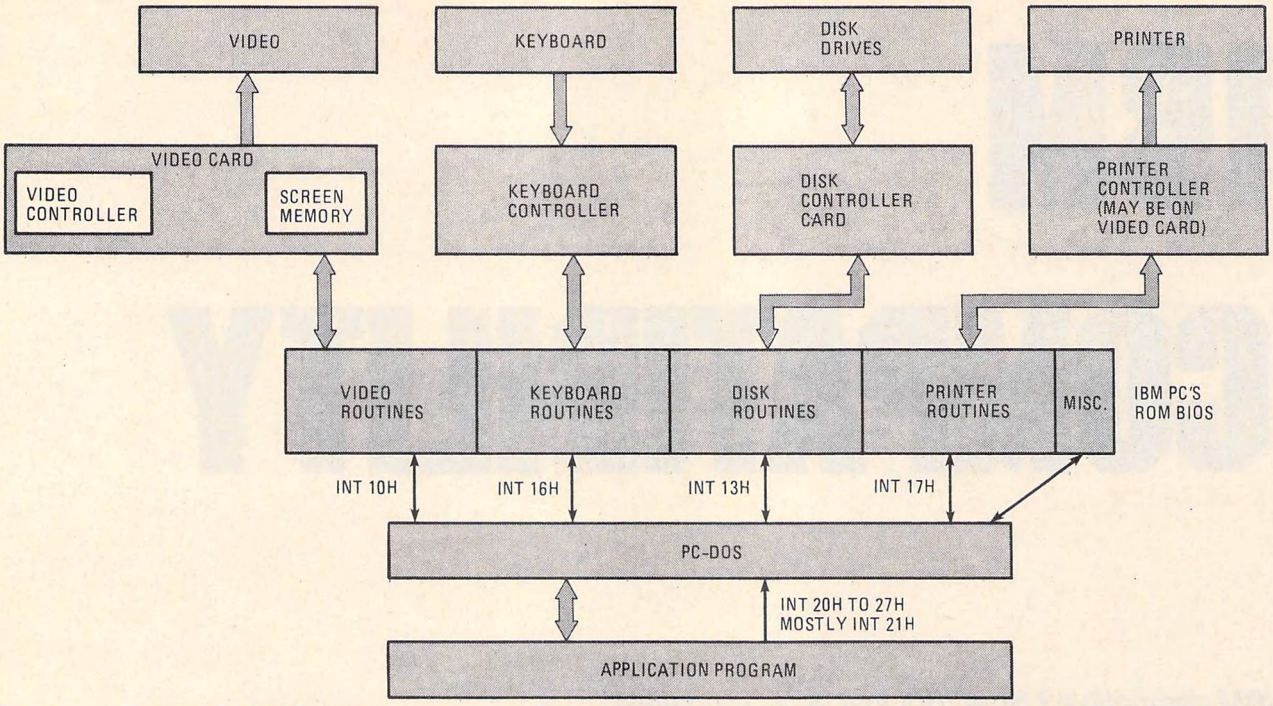


FIG. 1—AN APPLICATIONS PROGRAM can access IBM *PC* hardware through PC-DOS. However, a program can also access the *PC's* ROM directly, causing incompatibility.

such as the Leading Edge PC, Sperry PC, Corona, and Compaq—that can run just about any program available for the IBM *PC*. But there are others on the market, such as the Heath/Zenith *H/Z 100* series that can only read IBM data disks. And there are still others that are only "DOS-compatible," meaning they run MS-DOS but really can't handle program or data disks for the IBM *PC*.

Theoretically, any computer capable of running MS-DOS (*M*icro*S*oft-*D*isk *O*perating *S*ystem) is capable of handling any program or data disk created or used by another MS-DOS computer system. In *reality*, it just isn't true. But it's not due to any fault of the operating system. Programmers can develop applications programs that will run under MS-DOS and that won't be difficult to move from machine to machine. But because of the way in which the IBM-*PC*—and those who write programs for the *PC*—handle things, programs that are developed for the PC may or may not run on a machine that is supposed to be compatible. On some "compatible" machines, however, the developers consciously tried to give users access to the wide base of IBM-backed programs. They succeeded in that 95 percent or even more of the programs available for the *PC* will run directly on those machines. But, on others, the developers were only striving for operating-system compatibility—meaning that they wanted a machine that could run MS-DOS. On such machines, few, if any, IBM-*PC* programs will run directly. Of course that doesn't mean that the programs cannot be rewritten so that they will run under MS-DOS. But let's see why they are not written that way for the IBM *PC* which, after all, is an MS-DOS machine.

How IBM does it.

For a better explanation of why all "PC-compatible" machines aren't equal, let's take a look at how IBM does things.

When an applications program interacts with the PC hardware, it does so through PC-DOS. Keyboard I/O, video I/O, disk I/O, printer I/O, etc. are all handled by PC-DOS through software interrupts (which is something like calling a subroutine). But there is another way to access the PC hardware: through the *PC's* extensive ROM.

The advantage of using the PC's ROM instead of PC-DOS is that, in many instances, the ROM software lets you do more. For example, PC-DOS' video control is rather limited—its functions are much like those of a teletypewriter. You can send characters to the screen, but not much more. For example, you cannot directly position the cursor through PC-DOS. So word-processing programs, for example, go to the ROM, which contains extensive text- and screen-handling routines.

The routines in the PC's ROM are also accessed by interrupts. They can be accessed through PC-DOS (as shown in Fig. 1). But an applications program can "go around" PC-DOS and directly access the ROM-based routines. That (not shown in Fig. 1) is the real reason for the incompatibility problem.

The PC uses interrupt 10H (the H indicates a hexadecimal number) for video control, while interrupt 16H handles input from the keyboard. The system uses interrupt 17H to handle output to the printer, while disk input and output is handled via interrupt 13H (See Fig. 1). Those and other interrupts provide for most

programmers a chance to control the *PC* more completely than PC-DOS does. They write their applications programs accordingly.

For instance, when a programmer implements interrupt 10H to have direct access to the PC's video capabilities, he is given access to a set of powerful, proprietary, ROM-based routines; with those powerful routines he can make the screen do just about anything he wishes.

Interrupt 16H is used to access keyboard routines. PC-DOS can be used to get information on the keyboard. But programmers prefer to use interrupt 16H directly. You see, the *PC's* keyboard not only has the usual range of keys, but it also has 10 special function keys, and it is capable of generating an alternate set of characters. Some of the key codes are non-ASCII. PC-DOS can pass their values back to the program, but the ROM routine can do it in a more convenient form. So programmers use it.

The fact that so many programmers make use of the *PC's* ROM routines directly makes it hard for users of non-IBM machines. If you try to run a PC-DOS program on your IBM "compatible," you may find that the program makes many calls directly to the *PC's* ROM that may or may not be matched in your MS-DOS machines.

Of course, some developers have purposely opted to build their machines following IBM's blueprint as closely as possible, and some machines are more compatible than others. But on many machines, programs that use the proprietary capabilities of the *PC* will either fail to run or will run erratically, causing strange results or screen messages.

Levels of compatibility.

If all things were equal in the world of microcomputers, then any program written to run under MS-DOS (PC-DOS) would be able to work on any MS-DOS machine. But, as we have seen, that just isn't the case. If you want a machine with 100% compatibility, a machine that will run all programs written for the *PC* without any surprises, then your only choice is to buy an IBM *PC*.

However, there are manufacturers who have chosen to implement IBM-like functionality in their machines and have made them nearly identical in capability with the *PC*. But don't forget that there are others who have only given their machines data-level compatibility, and still others who have chosen only to use MS-DOS without attempting to emulate the IBM *PC*. In a moment we will see the differences between those levels of compatibility.

In all honesty, there are limits to what the manufacturers can do because the routines contained within the *PC's* ROM are proprietary and copyrighted. So those companies that have chosen to implement a nearly IBM-like system have been forced to do massive amounts of engineering in order to achieve IBM-like capability, without violating any copyrights. An almost-fully-compatible machine must provide ROM calls like those in the *PC* (but they don't have to be in ROM). For close compatibility to be achieved, the video memory must also be like the *PC's*.

With that said, you can now see that there are levels of PC-compatibility. The first level is nearly total compatibility, with the machine capable of using IBM programming and data disks and having the ability to create disks which can be read and used by the *PC*. The programming for those machines will also usually run without modification on the *PC*. (Although there will likely be some problems with BASIC unless each machine converts the BASIC instructions into the same single-byte tokens.) Near-total compatible machines can use *PC* programming and data disks, but their BASIC implementation will probably be different.

The next level can be considered system level or data compatibility. An example of such a machine is the Heath/Zenith *H/Z-100*. That microcomputer is capable of using IBM-generated data disks, but will run few, if any, PC-DOS programs. Instead, the user must employ a program ported over to the specific machine, but written under MS-DOS.

In this category of machine, the subtleties of the programmers become apparent. Because PC-DOS programmers make use of calls directly to IBM hardware, those calls usually don't work correctly on the data-compatible machines. The result is that programs that work correctly on the PC either won't run on the data-compatible computers or will run poorly, at best. If you can get them to boot and run, the chances are good that at some point in the program, your computer will head off into never-never land with the disk drive spinning.

The final category of machine is the DOS-compatible machine. That is, a computer that only uses the MS-DOS system and heads its own way as far as implementation and programs are concerned. It usually won't run any *PC* program and it usually can't use a *PC's* data disk. About the only apparent justification for calling it "PC-DOS-compatible" is from a marketing standpoint. It is apparently an effort on the part of the manufacturer to climb on the IBM bandwagon and gain from the popularity of the machine.

Two good tests.

So how can you determine if a machine is a true compatible, a data compatible, or a DOS-compatible? There is an easy test, involving the programs *Microsoft Flight Simulator* and *Lotus 1-2-3*.

Those programs make heavy demands on screen and keyboard interrupts and machine calls. If they will run on a system being considered, then it is a good bet that it is a (nearly) true compatible. But if the computer just sits there with no reaction, then the machine is either only data compatible or DOS-compatible. If you are looking for a true compatible then that system isn't for you.

However, if you all you want is MS-DOS software and the ability to have 16-bit IBM-like power at your fingertips, as well as the broad variety of software available, then a data-compatible or DOS-compatible machine is the ticket because you can take advantage of familiar software names that have been ported to these machines.◀CD▶

DIAGNOSTIC SOFTWARE FOR DISK DRIVES

Diagnose sick disk drives before they give you trouble.

HERB FRIEDMAN

■Of all the various devices that go into a personal computer system, more often than not it's the disk drives that cause the most problems. If a computer fails, it fails: the screen fills with garbage and you know to press the reset key or recycle the power. If the printer fails it also fails: it stops printing, or feeding paper, or a good percentage of the printing is the wrong characters.

But a disk drive...it fails with finesse. It will work fine for 15 minutes, then fail to read data, and when you go to check it out it's back to reading data properly. Or it stores data on Monday, then won't feed it out on Tuesday. Or disk A: won't read data recorded on disk B:, while disk C: won't read data recorded on the computer in the next office.

Disk drives are very fussy, and rightly so. Consider, for a moment, the precision that we expect from something that sells for something like $200 (the cost of a "bare" drive—meaning without power supply or case). We expect it to put down, in the space of 0.8 inch, at least 40 magnetic tracks that are so precisely positioned they can be sensed by any other disk drive (for the same computer) any where, any place, in any environment, anywhere in the world. We expect the polarization of the magnetic fields (the "alignment") to be so precise that data can be recorded on any disk drive and read by any drive. We expect the mechanism itself to be so precise that if we cycle the drive hundreds of thousands of times, the read/write head will always be positioned right where it belongs.

Yes, we ask a lot from disk drives. That they work so well is almost magical. But disk drives work within such narrow tolerances that if wear or aging affects anything concerning the mechanical system the whole system "crashes."

Though a disk drive has many critical areas, for many years the only test commonly available to the average user was the "speed test." The speed of the 5¼-inch floppy disk is standardized at 300-RPM ±2%. Actually, we strive for ±1% because ±2% is really 4% "worse case." (Figure it out: If disk A: is 2% high and disk B: is 2% low, though both are within tolerance, the disparity is 4%—and that's looking for big problems if any other adjustment isn't right "on the money."

The typical speed test is done with software that provides a screen display of the disk speed, either through direct numerical values or through a graphic display. There are speed-test disks available for just about every major computer. Prosoft's (Box 560, North Hollywood, CA 91603) speed-test program called *RPM*, whose screen display is shown in Fig. 1, is representative of the better speed-test software. It continuously updates the data display, while the range of variation is stored by the graphic display—providing a visual indication of the speed range.

Most of the speed-test software available for personal computers is "memory resident," meaning the program loads into memory so the disk itself can be removed. The software disk must be removed because the software records test signals on a "blank" disk. (The speed test(s) will destroy any data on the disk.)

If you have ever examined a disk drive you will wonder why in heck you need test software when the

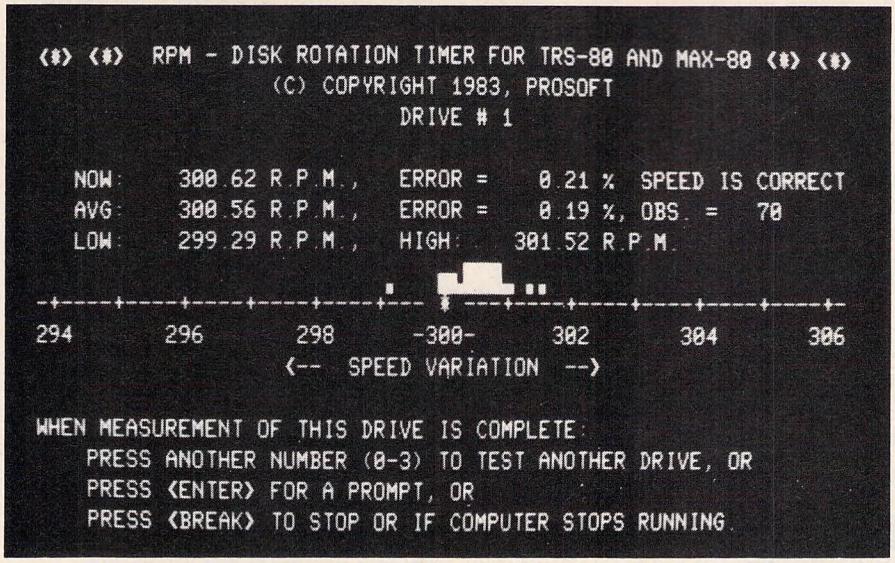

(*) (*) RPM - DISK ROTATION TIMER FOR TRS-80 AND MAX-80 (*) (*)
(C) COPYRIGHT 1983, PROSOFT
DRIVE # 1
NOW: 300.62 R.P.M., ERROR = 0.21 % SPEED IS CORRECT
AVG: 300.56 R.P.M., ERROR = 0.19 %, OBS. = 70
LOW: 299.29 R.P.M., HIGH: 301.52 R.P.M.
294 296 298 -300- 302 304 306
<-- SPEED VARIATION -->
WHEN MEASUREMENT OF THIS DRIVE IS COMPLETE:
PRESS ANOTHER NUMBER (0-3) TO TEST ANOTHER DRIVE, OR
PRESS <ENTER> FOR A PROMPT, OR
PRESS <BREAK> TO STOP OR IF COMPUTER STOPS RUNNING.

FIG. 1—THE DISK-DRIVE PROGRAM *RPM* displays the speed drift in both direct quantities and on a bar graph. Note the frequent read errors displayed on the graph.

disk drive mechanism has a "strobe" pattern on the flywheel or stabilizer (the metal weight attached to the back of the spindle that rotates the disk). Examined under the "pulsating" light from a fluorescent or neon lamp, the strobe pattern will appear frozen when the drive is running precisely at 300 RPM. So why use software when we can observe a strobe?

There are several reasons why software is preferable to "reading the strobe." First, you don't want to disassemble the drive's cabinet in order to view the strobe every time you feel it necessary to test the disk speed: it's a lot easier just to run software from a disk. Second, unless you're very skilled, it's almost impossible to determine if the speed is within tolerance, if the pattern is "drifting." Third, the strobe pattern doesn't easily disclose "crossover drift." By the time you notice the strobe pattern indicates a "low speed," the drive is running at a "high speed;" a real problem if you're attempting to adjust the disk drive's speed yourself.

Until recently, virtually all 5¼-inch drives in common use had a user-accessible speed adjustment. Generally, it was some form of trimmer potentiometer that could be adjusted using a small screwdriver or a TV-alignment tool. If a test disk disclosed that the disk speed was incorrect, the user could bring it "on the mark" by simply running the software and adjusting the potentiometer until the screen presentation was as close as possible to 300 RPM.

But technology eventually outruns the consumer. Some (and soon all) of the modern disk drives have electronic servo speed control that is often referenced to a crystal-controlled oscillator; hence, there is no user adjustment. The most the speed test disk can do is indicate whether the servo circuit has failed: the actual repair or adjustment must be made by a service shop.

Speed checks aren't enough

Poor speed adjustment is just one of the many things that cause disk read errors. Unfortunately, until recently the only software available to the average user tested only the disk speed, nothing else. The specialized software that tests all the disk drive adjustments, such as clamping (hub eccentricity), head alignment and sensitivity, mechanism hysteresis, and head azimuth was available only to the disk manufacturers.

Actually, all the required tests are on a single special diagnostic test disk manufactured by Dysan (5201 Patrick Henry Drive, Santa Clara, CA 95050), the same people who produce high-performance blank disks. The problem is that the Dysan diagnostic requires a

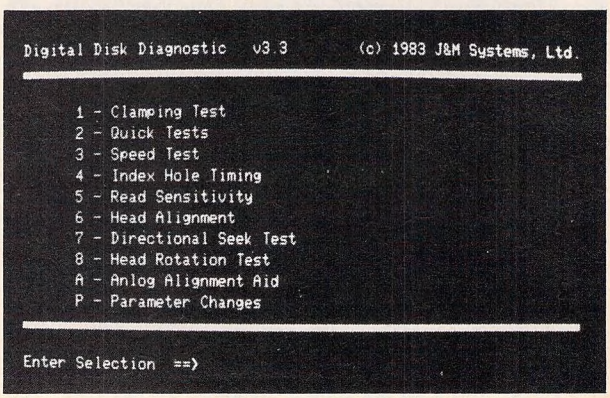

Digital Disk Diagnostic v3.3 (c) 1983 J&M Systems, Ltd.
1 - Clamping Test
2 - Quick Tests
3 - Speed Test
4 - Index Hole Timing
5 - Read Sensitivity
6 - Head Alignment
7 - Directional Seek Test
8 - Head Rotation Test
A - Anlog Alignment Aid
P - Parameter Changes
Enter Selection ==>

FIG. 2—THE MENU FOR J&M's DDD test disk. Other software well might have a different menu for the same functions.

separate in-memory runtime program written for a specific computer, so until recently the diagnostic disk wasn't available to the average user.

But create a need and someone will write the necessary program. Presently, J&M Systems (137 Utah NE, Alburquerque, NM 87108) markets a complete diagnostic kit consisting of the Dysan Diagnostic Disk and a separate disk with runtime software written specifically for the Radio Shack Models *III* and *4*. By the time you read this article, Dysan themselves will have introduced a disk-drive diagnostic package for the IBM *PC* (and expects to have diagnostic packages available for other computers in the near future).

The Dysan Diagnostic Disk—which they and everyone else refers to as the DDD—is read-only and contains many different standardized tests and checks recorded in precisely-positioned tracks. When you run

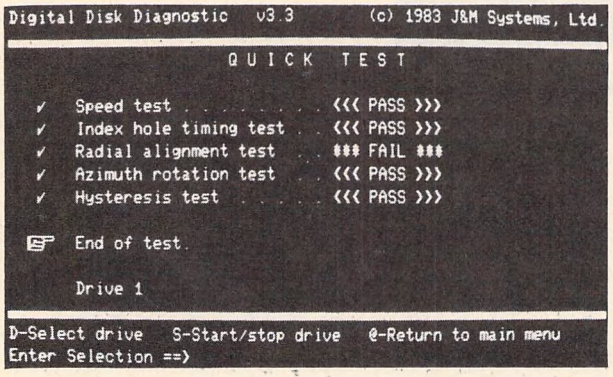

Digital Disk Diagnostic v3.3 (c) 1983 J&M Systems, Ltd.
QUICK TEST
✓ Speed test . . . . . <<< PASS >>>
✓ Index hole timing test . . <<< PASS >>>
✓ Radial alignment test . . ### FAIL ###
✓ Azimuth rotation test . . <<< PASS >>>
✓ Hysteresis test . . . . . <<< PASS >>>
End of test.
Drive 1
D-Select drive S-Start/stop drive @-Return to main menu
Enter Selection ==>

FIG. 3—THE *QUICK TEST* does just what it claims: It tests the drive and compares the results against built-in standards. Note that the drive failed the radial-alignment test.

the DDD you are actually comparing the performance characteristics of your disk drive against recognized standards.

While the visual displays will depend somewhat on the specific diagnostic package you use for your computer, the J&M screen displays are representative of what you can expect. While no one suggests that you muck around inside the drive and try to make adjustments using the screen display, it's really possible for a skilled technician to calibrate a drive using the

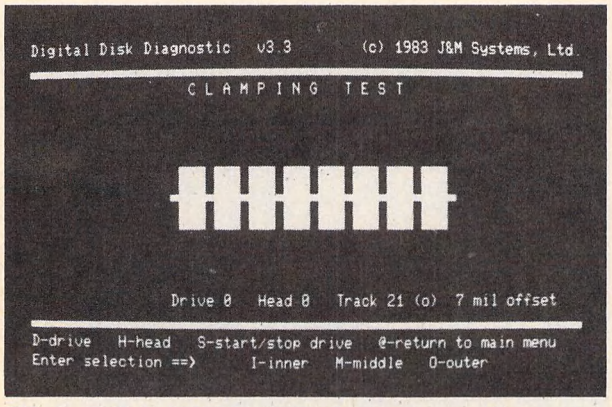

Digital Disk Diagnostic v3.3 (c) 1983 J&M Systems, Ltd.
CLAMPING TEST
Drive 0 Head 0 Track 21 (o) 7 mil offset
D-drive H-head S-start/stop drive @-return to main menu
Enter selection ==> I-inner M-middle O-outer

FIG. 4—THE CLAMPING TEST checks the condition of the disk's hub, and also the drive's clamping mechanism. The eight rectangles indicate that the disk is properly centered.

DDD. In fact, some of the tests are specifically intended for aligning the drive.

All tests are selected from the main menu shown in Figure 2. The DDD provides several individual tests, but if you're in a hurry and want to do quick-and-dirty periodic checks, the DDD contains a "Quick Test" for speed, index-hole timing (you've never heard of that test?), radial alignment (or that one?), Azimuth rotation, and hysteresis. (See Fig. 3.)

The quick test has its own *pass-fail* limits that are compared against the results of the other tests which are run automatically by the resident software. Unlike the individual tests which provide reference values, the quick-test screen display is pass-fail. If you want more specific information, you can run the individual tests.

The first specific test to run is for *clamping*, as shown in Fig. 4. Clamping is a function of the condition of the diskette's hub. The purpose of the clamping test is to insure that the test disk is properly centered around the drive spindle. Also, the clamping test checks the alignment of the read/write head. If the screen doesn't display a perfect set of eight rectangles, as they say, "You got big trouble!" It's probably the reason that disks written in drive A: gives read errors when read in drive B: (and vice-versa).

The clamping test proved to be an accurate guide to the overall performance of disk drives. We had one computer with three drives (Nos. :0, :1, and :2) that was producing sporadic read errors on drive :1. The first time we ran the clamping test we got nowhere near the eight rectangles on drive :1. Further tests indicated just about every conceivable problem with the drive. While no problem was extreme, they combined to produce a worst-case condition—having errors at the limits of the tolerance ranges—that resulted in sporadic read errors.

For example, the speed test, which is indicated on a bar-graph screen display calibrated from 294 to 306 RPM with 300 RPM at the center. (The maximum limits of ±2% are represented by 294 and 306 RPM.) Drives :0 and :2 produced readings which—more or less—remained where they started out. Drive :1 produced a reading that wandered back and forth, always within tolerance but continuously drifting—an obvious harbinger of doom to come.

For soft-sectored disks—the kind with only one

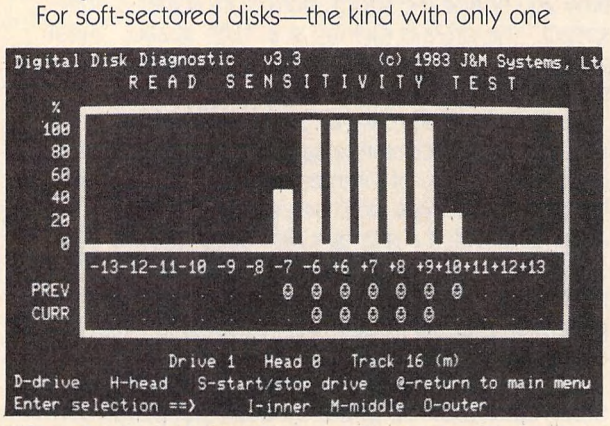


FIG. 5—READ SENSITIVITY is a good indicator of the ability of a drive to read disks recorded on other drives. The display shown indicates that drive 1 passes, but barely.

sector hole—between 100 and 30 microseconds should elapse from the leading edge of the index hole to the beginning of the sector mark. The measured timing is indicated by a bar graph with 200 microseconds—the optimum value—at the center. Actually, unless the drive literally falls apart or the LED that shines through the hole or its photodetector fails, you should never find the screen display in error. If you must align the index hole timing simply move the photodetector while observing the display. (*Don't* do it unless it A) needs it, and B) you know what you're doing.)

Read sensitivity is the ability of the drive to read low-level signals from the DDD. The signals that test for sensitivity are recorded progressively offset from the centerline of the track. The more sensitive the head the greater the offset that can be read.

As shown in Fig. 5, sensitivity is indicated by a special bar graph that indicates how many times out of five tries the offset is read. The results are expressed in percent. (As the drive mechanism ages, the upper and lower limits of the display are reduced.)

The same bar graph is used to indicate head alignment. If the bars are displaced, the head is out of alignment. As we've discovered, if all heads are similarly out of alignment, they cancel the error and disks from drives having the same misalignment can be read (within limits). But read errors can occur when a

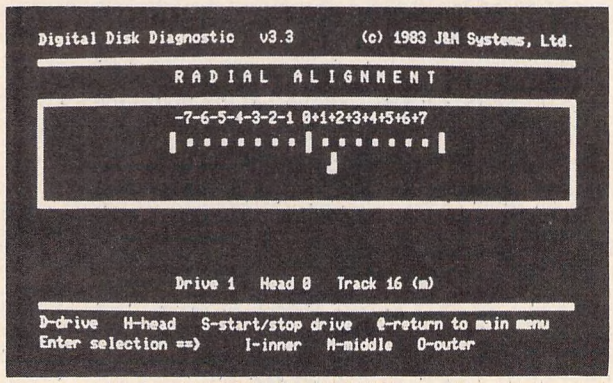

Digital Disk Diagnostic v3.3 (c) 1983 J&M Systems, Ltd.
RADIAL ALIGNMENT
-7-6-5-4-3-2-1 0+1+2+3+4+5+6+7
Drive 1 Head 0 Track 16 (m)
D-drive H-head S-start/stop drive @-return to main menu
Enter selection ==> I-inner M-middle O-outer

FIG. 6—THE RADIAL-ALIGNMENT TEST must be interpreted in terms of the other tests. Here, drive 1 is shown in alignment, yet all other tests, including the Quick Test, indicated a problem with drive 1. The reason the Quick Test failed is because it combines both read sensitivity and head alignment into the "radial-alignment" quick test.

misaligned head tries to read data recorded on a properly aligned head, or one misaligned on the opposite side of the center mark.

The radial-alignment test is similar to the read-sensitivity test except only the center of the total good sectors is displayed, thereby making for a much more sensitive display when aligning a drive. As shown in Fig. 6, a special zero-center radial-alignment bar graph is displayed, and the object is to adjust the head alignment so that the display is as close as possible to the center of the scale—the "0" mark.

The directional-seek test is the one that exposes really worn mechanisms because it tests the

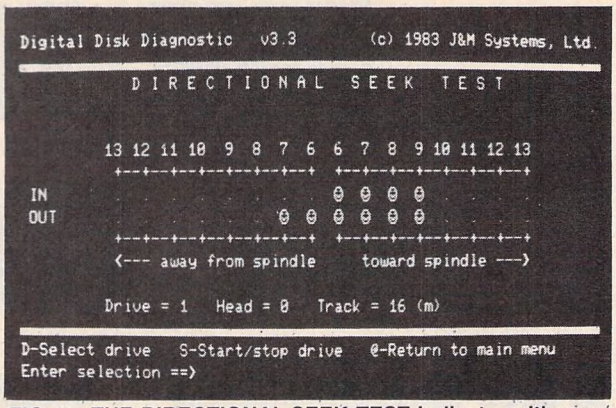

Digital Disk Diagnostic v3.3 (c) 1983 J&M Systems, Ltd.
DIRECTIONAL SEEK TEST
13 12 11 10 9 8 7 6 6 7 8 9 10 11 12 13
IN
OUT
<--- away from spindle toward spindle --->
Drive = 1 Head = 0 Track = 16 (m)
D-Select drive S-Start/stop drive @-Return to main menu
Enter selection ==>

FIG. 7—THE DIRECTIONAL-SEEK TEST indicates either excessive wear or a poorly manufactured drive. Note the results from drive 1, our problem drive.

mechanical parts that move the head back and forth, the parts that get the most wear. This test uses "happy faces" to indicate both proper operation and misalignment. (See Fig. 7.) If the two rows of happy faces aren't in alignment it's likely the head-positioning hysteresis is defective. It works this way: The head is moved *inwards* to the test track and then *outwards* to the test track. If the mechanism isn't worn, it will center on the test tracks regardless of which direction it is moved. If the head positioning mechanism *is* worn, the head takes different positions on the inward and outward positioning. Each direction is represented by its own row of happy faces; if they are stacked one above the other the alignment is perfect. The greater the radial misalignment of the head the greater the misalignment of the happy faces.

The head-rotation test or azimuth test is analagous to the alignment test for conventional audio tape recorders. It provides an indication of the angle at which the head intercepts the track's center-line. It uses a special bar-graph display that indicates centering of the pattern. The better the centering, the more precise the head's alignment with the track.

To assist the technician in adjusting the disk drive, the J&M package contains a special *Analog Alignment Aid* program that provides such functions as disk-drive start and stop, select drive, step head in and out, seek track, restore to track 0, etc. All those are procedures for a *qualified* service technician. In no way should the casual user, or even a computer hobbyist, attempt a drive alignment with the program. It requires special knowledge and test equipment, and the service manual for the specific drive.

Summing up

Though diagnostic disks were originally intended for the service technician, they are an invaluable aid to even the applications-oriented user when disk drives start to do peculiar things: when they read properly on even days of the week, but not on the odd days; when they read only when the disks are warm; when disks from drive C: will read in drive B: but not in drive A:. At the very least, they give you an insight into whether the trouble is in the drive or the computer.◀●▶

HOW TO MAKE YOUR COMPUTER'S MEMORY NON-VOLATILE

TJ BYERS

Don't let power failures wipe out that valuable data forever!

■Ask any computer enthusiast a question about his system—*any question*—and his answer will likely ring with sounds of 64K, 128K, and so forth. Memory has become a buzzword within the computer community. Usually, the larger the memory cache, the more powerful the machine is considered to be.

In large part, most computers use static or dynamic RAM IC's for their memory. Unfortunately, semiconductor memory is volatile. Once power is removed from the device, whether it is accidental or intentional, everything is "forgotten." The sudden loss of power can be most frustrating when you're running a long program or doing word processing. Hours of work can be wiped out in a split second.

Unquestionably, there is a need for a memory that can retain its contents even in the wake of a disaster.

Battery support

The most obvious solution is to place a battery within the memory circuit. Basically, the battery is paralleled with the main power supply and maintained in a standby state until it is needed.

Under normal operating conditions, the computer's main power supply is operating and furnishing power to the RAM. In the event of a power failure, however, the power supply drops out of commission and the battery takes over the task of supplying power for the memory so that the data is not lost.

It is fortunate, indeed, that most memory IC's don't require a full 5 volts in order to retain their stored bits. You'll find that the IC's will maintain their memory with voltages as low as 3 volts. That means that a 5-volt power source is not essential for memory support. Lower voltages can be used, thus relaxing the battery requirements.

Battery isolation

To prevent damage to the battery by the power supply during normal operation, a switching circuit is employed to remove the battery from the circuit unless it is needed. A simple diode switch, like the one shown in Fig. 1, does an excellent job of isolating the battery from the power supply.

The switching circuit uses two diodes to steer currents in the proper direction at the right time. Remember, the battery voltage is normally lower than the 5-volt power supply; it is usually in the neighborhood of 3 to 4 volts. Because the power

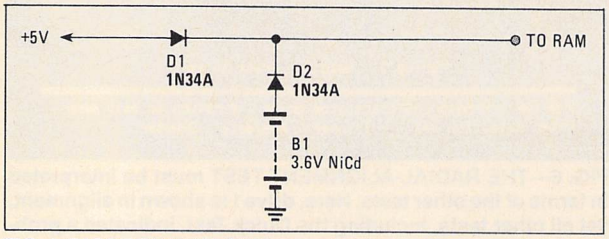


FIG. 1. DIODES WITH LOW forward voltage drops work best in this circuit. Although Schottky diodes usually come to mind first, the trend has been to germanium diodes such as the 1N34A.

supply voltage is higher than the battery voltage, diode D2 becomes reverse biased. Hence no current can flow either to or from the battery, thus isolating it from the rest of the circuit.

When the 5-volt source is removed, though, D2 is no longer reverse biased, and current can flow from the battery and provide power for the RAM IC's. Diode D1 now acts as a blocking diode which prevents the battery current from backing up into the power supply and other computer circuits.

A common choice for the auxiliary battery is the NiCd or nickel-cadmium cell, (commonly known as a "NiCad").

Battery monitor

The voltage across a fully-charged NiCd cell is about 1.2 volts. By stacking three NiCd cells in series, we can make a battery with an output of 3.6 volts—well within the range needed for memory protection.

NiCd batteries have virtually flat discharge curves, which makes them very attractive for computer applications. However, leakage current inside the battery causes the cells to self discharge. The amount of self discharge is dependent upon the type of battery you use and its surrounding temperature. Regardless of the battery though, the entire charge will eventually bleed itself off.

Now this battery death could occur at a most inopportune moment—usually when you least expect it. A quick check of the batteries from time to time will eliminate the problem. But that simple chore often goes undone until it's too late.

Fortunately, Intersil (10710 N. Tantau Ave., Cupertino, CA 95014) makes an inexpensive battery monitor, the ICM7201, that can solve this problem. (That IC is sold through most Radio Shack stores.) Figure 2 shows a simple circuit that lets you monitor the battery voltage.

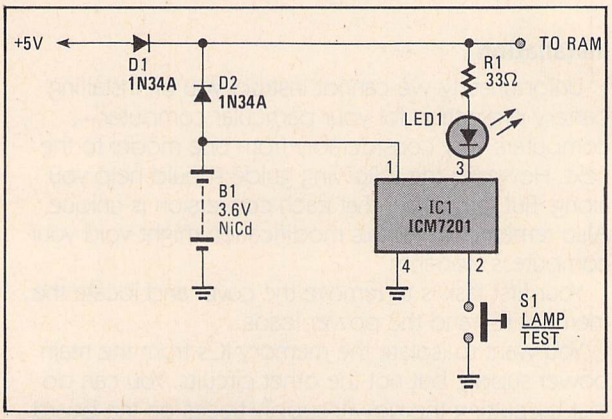


FIG. 2. GROUNDING PIN 2 will light the LED, thus providing a lamp-test feature.

The ICM7201 is a four-lead device that measures the voltage of your battery pack and can be used to give a visual indication of the battery's condition. As long as the battery voltage remains above 3.1 volts, the LED does not light. But if the voltage dips below 2.9 volts, the LED *will* light, indicating that only 5% of the battery's charge is left. That means that it's time you recharged your NiCd cells before they die altogether.

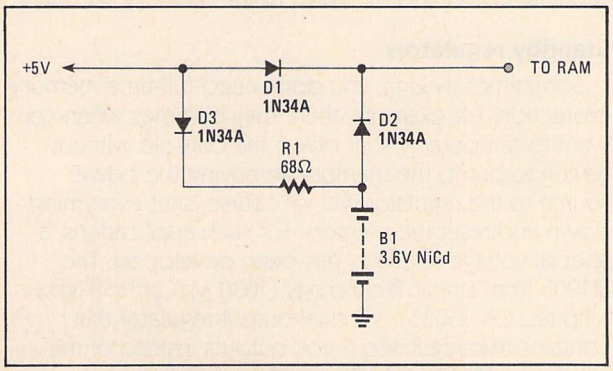


FIG. 3. A 68-OHM RESISTOR limits the charging current to 10 mA.

Battery charging

In most cases the NiCd's can be charged right from the 5-volt line. The charging current, however, must be limited. That's easily accomplished by inserting a resistor between the 5-volt source and the battery, as shown in Fig. 3. The value of the resistor is selected so that the charging current satisfies the charging requirements of the battery, while staying within the limits of the power supply.

Depending upon the cell you use and your particular system, the value of the current-limiting resistor will vary from one application to the next. Calculating the value of that resistor is easier if you realize that the battery is actually placed in a float application. That is, the battery doesn't ordinarily have to supply power and it simply "floats." That means it has plenty of time for recharging between uses. Therefore, the charging rate can be rather small in comparison to other charging schemes.

Normally, a trickle current is all that's needed to keep the battery alive. As a rule of thumb, the trickle current is numerically equal to or less than 10% of the battery's rated capacity. For example, a standard "C" size NiCd cell, which has a capacity of 1200 mAH, should be charged with 120 mA, no more. Otherwise you run the risk of overcharging the cell, and quickly destroying it.

Notice that another blocking diode, D3, has been added to the circuit. Its function is to prevent the discharge of the battery through the power supply via the charging resistor in the event of a power failure.

What battery size?

How long will a fully-charged battery last? That all depends upon the battery itself and the number and type of RAM IC's it has to support. Bipolar RAM's, like the 2101, are pretty power hungry, drawing as much as 5 mA each in the standby mode. CMOS memory IC's, on the other hand, draw very little current, and the battery can be expected to last considerably longer.

Size the battery to your memory power requirements and the time you need it serviced. Let's say, for example, that your memory demands 5 mA. If you select an "AA" cell, which has a capacity of 500 mAH, the battery can maintain the memory for about 100 hours. Remember, you will need three cells in series.

Lithium batteries

One of the problems facing the user of batteries for backup power has always been shelf life. The longer a battery sits, the more charge it loses, even if it's not being used. The NiCd overcomes that problem by constant recharging.

Unfortunately, charging circuits are bulky and expensive. They add to the cost of providing memory protection and require considerable board space.

Recently, a new battery has come into the picture which eliminates the shelf-life problem: the lithium battery. Lithium batteries have a shelf life that exceeds

ten years!

Lithium cells also have another characteristic that makes them particularly attractive for computer use. Most batteries, as you know, generate less than 2 volts. The carbon cell produces 1.5 volts and the NiCd stores 1.2 volts. A lithium cell, on the other hand, develops 3 volts. That means one lithium cell can do the work of two flashlight batteries or three NiCds.

That results in a considerable savings of space—a commodity so precious in cramped computer cabinets. And because lithium batteries are primary cells, they require no charging circuits.

When the lithium battery is teamed up with the CMOS memory IC, a natural match up occurs. (See for example, the non-volatile memory add-on for the Sinclair ZX81 in the July and August 1983 **Radio-Electronics.**) The newer static-RAM designs consume almost no power in the standby mode, and the lithium cell will last as long as its shelf life when used in this application *even with constant use!*

Consequently, many lithium cells come with solder tabs rather than button contacts. The battery is simply soldered in place right on the memory board. The chances of the battery going dead before you service the board are very slim.

A more recent development is the introduction of a RAM IC that contains its own battery source. That IC, manufactured by Mostek (1251 W. Crosby Road, Carrollton, TX 75006), plugs right into the same socket as a conventional memory IC and provides its own standby power in the event of a power failure.

Write protection

In most cases, it is not advisable to alter the data within the RAM after the operating voltage has dropped below 4 volts. That precaution is especially critical once the backup battery has taken over control of the IC. First, it requires more power to keep a RAM in its operating mode than it does to keep it in its standby mode. Since the battery already has a limited supply of power, that's important.

Second, and more important, the data bytes don't always write properly when they are entered under low-voltage conditions—the probability of an erroneous entry is quite high.

To protect against accidental data changes therefore, the write function must be disabled while the RAM is in the standby mode. That can't be done with our simple circuit of Fig. 1. We must instead go to a more sophisticated design, which senses the difference between the proper 5-volt input and a low-voltage condition. An example can be seen in Fig. 4.

Monitoring the supply voltage is a low-voltage sensor. That sensor can be built from a comparator. The output of the sensor drives switching transistors Q1 and Q2. When the 5-volt input is present, Q1 is switched on and Q2 is off. Current flows from the power supply, but not from the battery.

When the 5-volt line falls below the preset limit (usually 4.5 volts), the output of the low-voltage sensor toggles: Transistor Q1 drops out, and Q2 is activated. Battery power now supports the RAM. At the same time, the low-voltage sensor inverts the input logic to the NAND gate, which prevents the chip-enable signal from reaching the RAM. Essentially, the write operation is locked out.

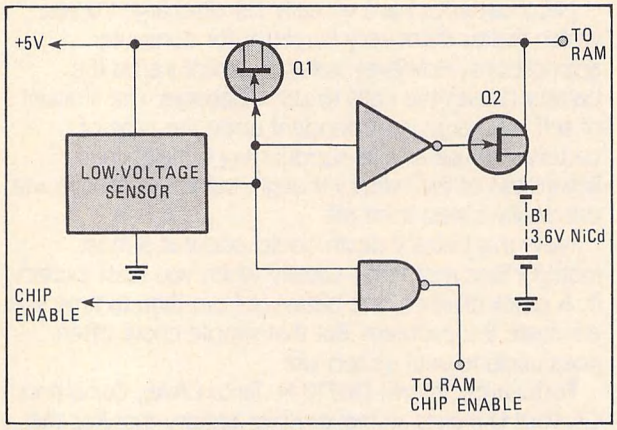


FIG. 4. IT IS NOT ADVISABLE to alter the data within the RAM after the operating voltage has dropped below 4 volts. The low-voltage sensor essentially locks out the write function when the +5-volt line disappears.

Installation

Unfortunately, we cannot instruct you on installing battery protection for your particular computer—computers vary considerably from one model to the next. However, the following guide should help you along. But remember that each conversion is unique. Also remember that this modification might void your computer's warranty.

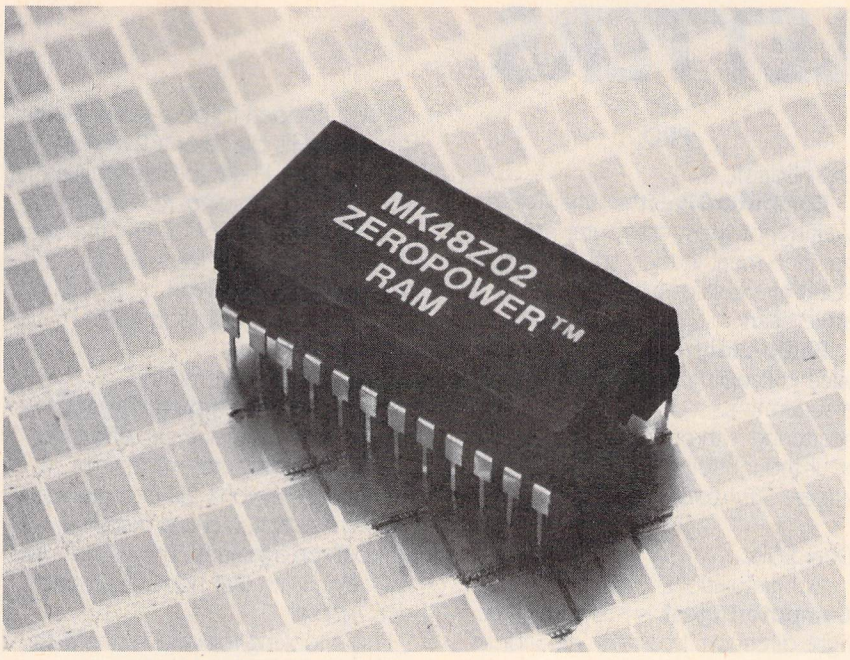
Your first task is to remove the cover and locate the memory IC's and the power leads.

You want to isolate the memory IC's from the main power supply, but not the other circuits. You can do that by cutting the power-supply traces on the board in the proper place using an *Exacto* knife. You may need to make two cuts: One at the input and one in the outgoing line(s). You can then use a jumper to bridge the gap and supply power to the other computer circuits.

Once that is done, all you have to do is to add one of the circuits—such as the ones in Figs. 1, 2, and 3. The hard part is making sure that the components fit on the computer board. If they don't, place them on a separate board and run wires to the memory section.

Standby regulators

Sometimes though, you don't need full-time memory protection. For example, there may be times when you want to temporarily shut down the console without having to dump the memory. Removing the power source to the regulator will, of course, shut everything down and reset the memory. For such applications, a special voltage regulator has been developed. The LT1005 from Linear Technology (1630 McCarthy B'lvd., Milpitas, CA 95035) is a dual-output regulator that contains *two* regulated 5-volt outputs instead of the usual one. (See Fig. 5.) The main power line is controlled by an enable pin on the regulator. A logic



THE MOSTEK MK48Z02 contains its back-up batteries within the IC package.

high to that input enables the main 5-volt output. Pulling the input low kills the output.

The second output is a low-current 5-volt source that supplies power to the memory portion of the computer. It too, is regulated. That output remains on, even if the main output is turned off or shorted.

In other words, the memory will be preserved while the bulk of the system is shut down.

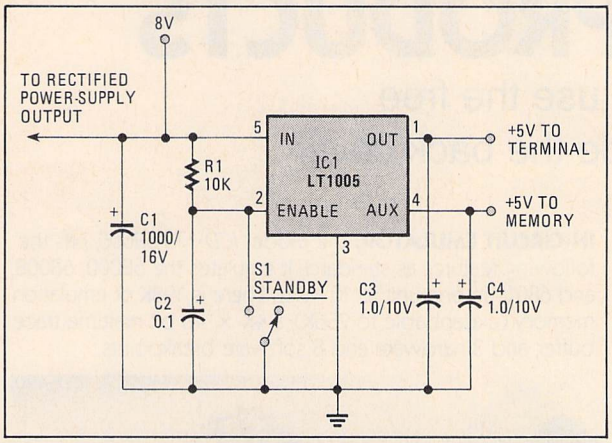


FIG. 5. A DUAL-OUTPUT REGULATOR can provide standby power for the memory while the main systems are shut down.

Mostek's MK48Z02

We metioned earlier an IC that contains a static RAM and lithium battery in one DIP (*D*ual *I*nline *P*ackage). The MK48Z02 combines the low power requirements of CMOS technology with the long lived energy of the lithium battery. But unlike other designs that use external lithium batteries attached to the memory board, the MK48Z02 contains its backup batteries right inside the IC package!

The memory portion of the IC contains a 2K by 8-bit CMOS static RAM. The unique thing about this RAM is its low power requirements. By using advanced CMOS technology, Mostek has been able to reduce the power consumption of the static RAM to an ultra-low 5 nanoamperes. That's about as close to nothing as you can get. In normal operation, the IC functions identically to any other static RAM and has an access time of less than 200 nanoseconds.

Also contained on the chip is an analog voltage sensing circuit that consumes very little power. The precision voltage sensor continuously monitors the +5-volt line. When the voltage falls below 4.5 volts, control logic within the sensor disables the RAM's write circuits and prevents the write-enable signal to the array from becoming active. That ploy locks the memory into the IC and prevents accidental data changes.

After the 5-volt line falls below 3 volts, a switching circuit connects one of the two lithium batteries to the RAM's power distribution bus and disconnects the external power supply. The sensor circuit monitors the voltage of the two batteries contained in the IC. Whichever battery has the highest voltage is the one selected to power the IC. The lithium batteries are removed from service once power is restored.

The batteries are actually welded into the case of the MK48Z02. In other words, they are not replacable. Just how long, you might wonder, will the batteries last? Well, with the combination of low-power consumption and high-battery power, the estimated life of the batteries is ten years.

What happens after the batteries are finally used up? Do they have to be replaced, or will the IC still function? According to Mostek, the IC simply reverts to a standard RAM. It will now use the 5-volt line to power its internal circuits, and completely disregard the internal batteries. Unfortunately, that leaves the memory vulnerable.

It appears that Mostek has succeeded in developing the perfect memory IC. They have avoided the pitfalls of EPROM's while maintaining nonvolatility.

LETTERS

PRO...

Dear Editor:

ComputerDigest is what I've been waiting for. Most computer magazines have no meat in their articles. They seem to be sales pitches for their advertisers.

Radio-Electronics had a good idea in keeping **ComputerDigest** as a separate section instead of scattering it throughout the magazine. Your thoughtfulness is appreciated.
Albert Shugzdis, Arkadelphia, AR

Dear Editor:

Congratulations! I think **ComputerDigest** is heading in the right direction. I cast my vote for its survival and perpetuation!

I pray the "old pros" and electronics purists will be unable to gang up and force you to abandon your new and most promising effort. I think it makes **R-E** all the more valuable.

I also happen to be a fan of Herb Friedman. His piece on CP/M was superb. Wish I had something like that a couple of years ago. Mr. Friedman does a terrific job of boiling the best out of his subject. Please tell him to keep up the good work.
William H. Raden, Toledo, OH

Dear Editor: I welcome the appearance of **ComputerDigest**. As you point out, no one can afford to buy all the computer magazines.

I hope you won't fall into the snare which has captured too many computer magazines. The world does not begin with IBM nor does it end with Apple.

I'll be looking forward to the next insert in **Radio-Electronics.** I've been a Gernsback fan since my youth.
Robert J. McGarvey, Kendall Park, NJ

...AND CON.

Dear Editor:

Regarding **ComputerDigest**: Although it hasn't taken any space away from the regular **Radio-Electronics** editorial features, it must cost a lot of money that could better be spent on developing a series, or several series of articles for the home experimenter. It looks like just another computer magazine, even though it claims otherwise. My subscription is to **Radio-Electronics** and I expect my subscription dollars to be spent keeping it the *best* electronics publication possible. I do not want its precious resources diverted to another computer magazine.
W. M. Tuleja, Boilingbrook, IL

Dear Editor: Regarding your new computer magazine, my advice is "Don't do it!" I want a magazine that covers the entire field of electronics. Sure, an occasional computer article is fine, but don't dwell on them. There is so much more in electronics that is equally, if not more fascinating.
Gary Gordon, Cincinnati, OH

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

CARTRIDGE WORD PROCESSOR, "*Write Now*", catalog number CØ2 is designed for the Commodore-*64* personal computer. It has a built-in 80-column display, and the user sees exactly what will print. Its features include: easy full-screen editing; compatibility with any printer; special codes

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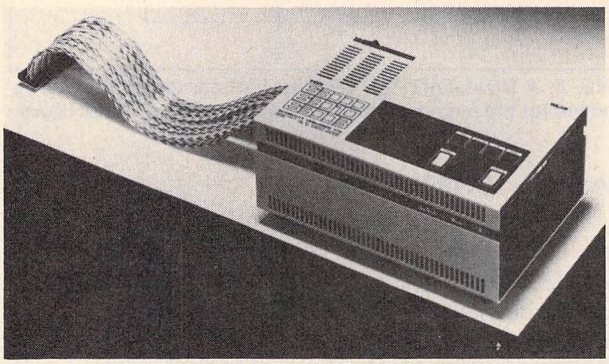
that can be transmitted to printers maintaining justification, and unlimited recall. Finding or replacing any copy is easy, and full-block command enables moving or deleting entire blocks of copy. The "*Write Now*" cartridge word processor is priced at $49.95.—**Cardco, Inc.,** 313 Mathewson, Wichita, KS 67214.

IN-CIRCUIT EMULATOR, the model *ICD-178 68000,* has the following features as standard: It emulates the 68000, 68008, and 68010 in one unit to 10 MHz. There is 128K of emulation memory (expandable to 256K), a 4K × 48 bit realtime trace buffer, and 3 hardware and 8 software breakpoints.



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The unit can also be connected to the IBM *PC* with optional software package that turns the *PC* into a complete development system for the 68000. The model *ICD-178 68000* is priced at $7,995.00.—**Zax Corporation, 2572 White Road, Irvine, CA 92714.**